

AD-A166 941

AIRCRAFT CARRIER FLIGHT DECK FIREFIGHTING TACTICS AND
EQUIPMENT EVALUATIO. (U) NAVAL RESEARCH LAB WASHINGTON
DC H W CARHART ET AL. 25 MAR 86 NRL-MR-5751

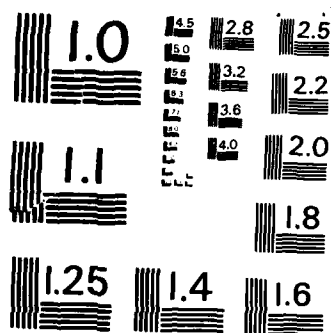
1/1

UNCLASSIFIED

F/G 13/12

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

2

NRL Memorandum Report 5751

Aircraft Carrier Flight Deck Firefighting Tactics and Equipment Evaluation Tests: Executive Summary

H. W. CARHART, J. T. LEONARD, R. L. DARWIN,* R. E. BURNS,†
T. J. HUGHES† AND E. J. JABLONSKI†

*Combustion and Fuels Branch
Chemistry Division*

**Naval Sea Systems Command
Washington, DC 20362*

*†Hughes Associates, Inc.
Wheaton, MD 20902*

AD-A166 941

March 25, 1986



DTIC FILE COPY

NAVAL RESEARCH LABORATORY
Washington, D.C.

Approved for public release. distribution unlimited.

RECEIVED
MAR 28 1986
E

075

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NRL Memorandum Report 5751		7a. NAME OF MONITORING ORGANIZATION	
6a. NAME OF PERFORMING ORGANIZATION Naval Research Laboratory	6b. OFFICE SYMBOL (if applicable) Code 6184	7b. ADDRESS (City, State, and ZIP Code)	
6c. ADDRESS (City, State, and ZIP Code) Washington, DC 20375-5000		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Naval Sea Systems Command	8b. OFFICE SYMBOL (if applicable) SEA 56Y5	10. SOURCE OF FUNDING NUMBERS	
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20362		PROGRAM ELEMENT NO. 63514N	PROJECT NO. SO384/ S1565-SL
		TASK NO.	WORK UNIT ACCESSION NO. DN020-158
11. TITLE (Include Security Classification) Aircraft Carrier Flight Deck Firefighting Tactics and Equipment Evaluation Tests: Executive Summary			
12. PERSONAL AUTHOR(S) Carhart, H. W., Leonard, J. T., Darwin, R. L.,* Burns, R. E.,† Hughes, T. J.† and Jablonski, E. J.†			
13a. TYPE OF REPORT Interim	13b. TIME COVERED FROM 3/82 TO 11/84	14. DATE OF REPORT (Year, Month, Day) 1986 March 25	15. PAGE COUNT 19
16. SUPPLEMENTARY NOTATION *Naval Sea Systems Command, Washington, DC 20362 †Hughes Associates, Inc., Wheaton, MD 20902			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
		Firefighting Monitors	
		Aqueous Film Forming Foam, Robots ←	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) ➤ Following the crash of an EA-6B aircraft on the flight deck of the USS NIMITZ on May 26, 1981, an extensive research program was undertaken to address possible deficiencies in shipboard firefighting procedures and systems and to identify potential areas for improvement. The test program included evaluation of existing shipboard equipment such as handlines, the flight deck washdown system and the P-16 firefighting vehicle, as well as proposed improvements such as high flow rate monitors (up to 12,000 gpm), hose tie down devices and robots. The effectiveness of both water and Aqueous Film Forming Foam in cooling ordnance exposed to a hydrocarbon pool fire was also investigated. The systems were evaluated in simulated aircraft carrier flight deck fires using a specially-designed debris pile fire as a standard or reference fire and under wind conditions of 0-30 knots. A total of 216 fire tests and 56 non-fire tests were conducted. As a result of this program, a number of actions have been taken including changes in firefighting doctrine that have already been implemented into the Fleet. The effectiveness of existing shipboard firefighting systems, when installed and used properly, was also confirmed. This Executive Summary summarizes the conclusions of the test program; complete details can be found in a companion report entitled, "Aircraft Carrier Flight Deck Firefighting Tactics and Equipment Tests" NRL Memorandum Report to be issued shortly.			
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL H. W. Carhart		22b. TELEPHONE (Include Area Code) (202) 767-2262	22c. OFFICE SYMBOL Code 6180

CONTENTS

	FOREWORD	iv
1.	BACKGROUND	1
2.	DEFICIENCIES	1
3.	PLAN OF ACTION	2
4.	EXPERIMENTAL	5
5.	RESULTS AND CONCLUSIONS	8
6.	ACTIONS TAKEN	13

Accession For

NTIS GRA&I ☒

DTIC TAB ☐

Unannounced ☐

Justification

A-1



FOREWORD

Following the crash of an EA-6B aircraft on the flight deck of the USS NIMITZ on May 26, 1981, an extensive research program was undertaken to address possible deficiencies in shipboard firefighting procedures and systems and to identify potential areas for improvement. This Executive Summary summarizes the conclusions of the test program; complete details can be found in a companion report entitled, "Aircraft Carrier Flight Deck Firefighting Tactics and Equipment Tests", NRL Memorandum Report, to be issued shortly.

AIRCRAFT CARRIER FLIGHT DECK FIREFIGHTING TACTICS AND EQUIPMENT EVALUATION TESTS: EXECUTIVE SUMMARY

1. BACKGROUND

On May 26, 1981, an EA-6B aircraft crashed into several parked F-14's while attempting to land on the USS NIMITZ (CVN-68). As a result of the crash and the ensuing fire and explosions, 14 persons were killed and 42 injured. Damage was estimated at \$60 million of which over \$53 million was attributed to destroyed and damaged aircraft.

Firefighting efforts were initiated immediately after the crash. However, the countermeasures washdown system, which dispenses Aqueous Film-Forming Foam (AFFF) through nozzles located in the flight deck, and along the deck edge, was not activated until more than two minutes after the crash. The upwind zones produced only seawater for the duration of the fire due to electrical malfunctions in the AFFF pump circuitry. Meanwhile, the fire was fed by the flow of JP-5 fuel from at least one F-14 aircraft, which had just been refueled prior to being struck by the crashing EA-6B. A total of three F-14 aircraft were involved in the fire, each of which was armed with a Sparrow, a Sidewinder, and a Phoenix missile and an undetermined quantity of 20-mm ammunition. Throughout the fire, handlines (fire hoses) dispensing sea water were used in an attempt to cool the various ordnance in order to prevent explosions (cook-off). The fire was declared out after a duration of about 19 minutes, and firefighters moved in to overhaul smoldering debris. Shortly thereafter, a Sparrow missile, which was concealed in the debris, detonated killing two and injuring 29 persons.

2. DEFICIENCIES

The following deficiencies in fire protection and other contributing factors were cited in the subsequent investigation reports:

1. Failure of the upwind washdown zones to produce AFFF;
2. Loss of deck edge nozzles in the fire area;
3. Inability to get hose teams, MB-5, and P-16 firefighting vehicles upwind of the fire;
4. Dilution and washing away of AFFF solution by saltwater discharge from handlines and upwind washdown zones;

Manuscript approved January 10, 1986.

5. Major debris which shielded the fire, and possibly blocked flush deck nozzles in the fire area;
6. Six out of nineteen flush deck nozzles in the fire zone were internally clogged prior to the incident;
7. Delay in activation of washdown system;
8. Ordnance cook-off and intense burning of ordnance filler;
9. Involvement of aircraft components (composites, liquid oxygen, hydraulic fluid, engine oil, ejection seats, explosive jettison devices, upholstery, cushioning, harnesses, belts, plastic hoses, insulation, cables, etc.);
10. Possible large running fuel fire in the debris pile.

3. PLAN OF ACTION

At the direction of the CV Firefighting Flag Level Steering Committee, a plan of action was developed to address voids in knowledge of the firefighting systems and procedures on the USS NIMITZ and to explore a number of other potential improvements in fire protection for use on flight decks. The objectives of the test plans which evolved were:

1. NIMITZ Tests

- a. Determine the decrease in firefighting efficiency resulting from use of water instead of AFFF in all or part of the flight deck washdown system;
- b. Determine the relative effectiveness of water and AFFF for ordnance cooling when using 1 1/2 in. and 2 1/2 in. handlines;
- c. Develop a reproducible running fuel fire in a debris pile for use in subsequent tests as a standard to obtain comparative data (to be called a "debris pile fire");
- d. Develop tactics for extinguishing a debris pile fire;
- e. Establish time for ordnance cook-off by measuring heat rise and cooling rates of instrumented missile motor cases;
- f. Examine the relative firefighting effectiveness of 1 1/2 in. and 2 1/2 in. handlines.

2. Monitor Scoping Tests

a. Phase I

- i. Determine the firefighting effectiveness of monitors with flow rates of 5,000 and 6,000 gpm against the shielded side of a debris pile;
- ii. Evaluate the firefighting effectiveness of monitors with flow rates of 500 to 2,000 gpm against the unshielded side of a debris pile;
- iii. Determine the fire extinguishing and ordnance cooling effectiveness of single and dual monitor applications.

b. Phase II

- i. Evaluate the effectiveness of monitors with flow rates from 250 to 2,000 gpm in combatting debris pile and pool fires;
- ii. Determine if a 12,000 gpm monitor can provide significant extinguishing or cooling advantages when operated against the shielded side of a combined debris pile and pool fire from long range (350 ft. under no wind conditions);
- iii. Determine how a 30 knot crosswind affects the extinguishment range of monitors with flows of 1,000 and 2,000 gpm against debris pile fires;
- iv. Determine how varying the angle of streams relative to the wind affects extinguishment range in attacks on debris pile fires.

3. Systematic Tests

a. Phase I (Non-fire Tests)

- i. Test various flows (from 1,000 to 12,000 gpm) for wind effects on stream reach and confirm previous data (from 100 to 3,000 gpm);
- ii. Determine the angles of elevation of nozzles for effective stream reach;

- iii. Evaluate the potential for injury to personnel and damage to aircraft by large firefighting streams.

b. Phase II

- i. Applying knowledge from Phase I, determine the maximum range for fire extinguishment in a 30 knot wind for 100 to 4,000 gpm flow rates against debris pile fires;
- ii. Determine the ability of a 1,000 gpm erectable monitor (at 30 ft. height) to extinguish a debris pile fire.

4. Concepts Evaluation Tests

- a. Evaluate the performance of higher flow washdown systems (60 to 250 gpm per nozzle) against debris pile fires as compared to the existing 30 gpm per nozzle design;
- b. Evaluate the existing and higher flow washdown systems from the upwind zone only in extinguishing a pool fire;
- c. Evaluate the feasibility of using tied down and un-manned hose control devices to direct handline streams against debris pile fires.
- d. Determine the effectiveness of the P-16 firefighting vehicle with various hardware configurations and agents (AFFF solution, Halon 1211, PKP) against debris pile fires.

5. Variable Height Monitor Tests

- a. Determine the effect of varying the height of a 6,000 gpm monitor in a 30 knot crosswind;
- b. Determine the effect of varying the angle of the nozzle into the wind on fire extinguishing range against a debris pile fire.

6. Concepts Refinement Tests

- a. Refine evaluation of increased flow washdown systems (60 to 250 gpm per nozzle) on debris pile fire;
- b. Evaluate the use of a remotely controlled robot with a 500 gpm monitor against a debris pile fire;

- c. Determine the feasibility of the use of blast protection shields by firefighters.
- 7. P-16 Improvement Test
 - a. Modify the P-16 firefighting vehicle and determine the effectiveness of this vehicle against pool and debris pile fires;
 - b. Evaluate the advantages of 125 gpm and 250 gpm turrets in extinguishing a debris pile fire.

4. EXPERIMENTAL

Preliminary tests were conducted at the Naval Research Laboratory, Chesapeake Bay Detachment Fire Test Facility in Calvert County, MD. These tests included development of the standardized debris pile to simulate the shielded running fuel fire that occurred on the NIMITZ. The final configuration of the debris pile consisted of a fuel delivery system ending in a horizontal slitted 3 in. diameter pipe 6 ft. above the deck from which normally 50 gallons per minutes of JP-5 was cascaded over six 2 x 3 ft. trays (Fig. 1). It was found that a flow of 50 gpm in the debris pile was somewhat more difficult to extinguish than flows of 25 or 100 gpm. The trays were surrounded by a 9 x 12 ft. cinderblock structure 5 ft. high with a sloping 12 x 15 ft. steel roof (Fig. 2). The preliminary tests were followed by large scale tests at the Naval Weapons Center, China Lake, CA, which included a simulated aircraft carrier deck equipped with a built-in washdown system, deck-edge nozzles, hose lines, wind machines, tankage, pumps, debris piles, mock-ups, etc. as needed for the tests (Fig. 3). Included in these tests were studies of the P-16 and the use of a robot for firefighting.

In order to assess the thermal insult experienced by ordnance involved in JP-5 pool and debris pile fires, and to evaluate the effectiveness of various cooling techniques in preventing ordnance cook-off, instrumented ordnance (Shrike and Sidewinder) were included in these tests.

A total of 216 fire tests, and 56 non-fire tests were run, from which the following results and conclusions were developed. These are grouped topically for easy reference.



R-1254

Fig. 1 - Running fuel cascade in debris pile



R-1255

Fig. 2 - Block debris pile



R-1253

Fig. 3 - Simulated flight deck test site, NWC,
China Lake, CA

5. RESULTS AND CONCLUSIONS

1. Normal Flow Washdown Systems

- a. The most effective use of the carrier washdown system on pool fires requires AFFF solution in both the upwind and fire zones. This combination controlled a pool fire on a clear deck in a 30 knot wind in less than 20 seconds and extinguished it completely within 30 seconds.
- b. Control and extinguishment were found to be faster in 30 knot winds than in 15 knot winds due to improved dispersion of the agent. Previous tests had demonstrated that extinguishment time is even longer in no wind conditions.
- c. With wind present, use of the washdown firefighting system in only the fire zone resulted in persistent "strips" of fire. Ordnance located in these "strips" would cook-off based on recorded temperatures, if other measures were not taken. Activation of the upwind zone eliminated these "strips" thereby removing the potential cook-off hazard.
- d. Simultaneously discharging water in the upwind washdown zone and AFFF solution in the fire zone could not extinguish a pool or debris pile fire.
- e. Water alone in the washdown system was ineffective in fire extinguishment and can spread pool fires.
- f. Debris on the deck degraded the fire extinguishing capability of the washdown system.
- g. Clogged flush deck nozzles increased fire control and extinguishment times significantly.

2. Increased Flow Washdown System

- a. For a pool fire on an unobstructed deck, and using the upwind washdown nozzles only, doubling the flow rate from 30 to 60 gpm/nozzle reduced the control time from 30 to 16 sec. No significant improvement was achieved by increasing the flow to 90 gpm/nozzle.
- b. The washdown system alone did not extinguish a standard debris pile fire in a 30 knot wind even with flows as high as 250 gpm/nozzle.
- c. In a 30 kt. wind, a partial debris pile fire (upwind wall removed) was extinguished only with flows of at least 90 gpm/nozzle.

- d. In applying washdown systems against a debris pile, agent flows of 90 gpm/nozzle or greater provided reductions in heat rise and increased cooling or ordnance.

3. Handlines

- a. Against a 4,000 sq. ft. pool fire with an aircraft mock-up and 30 kt. wind, both 1 1/2 in. and 2 1/2 in. hand lines were effective in achieving control in less than 30 sec.
- b. While 2 1/2 in. handlines, with their higher flow rates, cooled more effectively than 1 1/2 in. handlines, they were less maneuverable in firefighting. This was particularly true in 30 kt. winds.
- c. Use of two handlines with AFFF solution gave control and extinguishment of pool fires in nearly half the time required for a single handline. The best combination of two handlines was one 1 1/2 in., for maneuverability, and one 2 1/2 in. providing more flow.
- d. When using a combination of 1 1/2 in. and 2 1/2 in. handlines, the use of water in the 2 1/2 in. (rather than AFFF solution) increased control and extinguishment times by as much as 50%. This was true for both aggressive firefighting and with 50 ft. stand-off tactics.
- e. When ordnance was involved, the most effective strategy was to extinguish the fire promptly and then cool the ordnance rather than try to cool the ordnance and extinguish the fire simultaneously.

4. Washdown System and Handline Combination

- a. Washdown systems combined with 1 1/2 in. and 2 1/2 in. handlines were most effective when all systems used AFFF solutions. Use of water in any part of the system extends control and extinguishment times significantly.
- b. With combinations of washdown systems and handlines (or handlines alone), very aggressive handline tactics with AFFF solutions were required in order to extinguish a running fuel fire in a debris pile.

5. Monitors

- a. Within their effective range, all monitors (1,000 to 12,000 gpm) were found to extinguish debris pile fires, and to limit ordnance heat rise when the fire was attacked from the unshielded side.
- b. None of the monitors could extinguish the debris pile fire when directed against the shielded side.
- c. A 30 kt. wind reduced the effective range of monitors in a crosswind attack on a debris pile fire to less than 1/3 the distance under no wind conditions. Crosswind velocities as low as 10 kts. had significant impact on stream reach.
- d. Monitors, within their effective range, controlled ordnance heat rise to minimal levels (less than 50°F) when operated against other than the shielded side of the debris pile.
- e. The increase in effective crosswind range of monitors to extinguish debris fires was not proportional to increases in flow, higher flows giving progressively smaller increases in distance.
- f. When monitors were operated at a 60° angle into the wind, with access to the unshielded side of the debris pile, the fire was generally extinguished at ranges 25% to 50% greater than in a 90° crosswind.
- g. To be effective under crosswind conditions with access to partially shielded debris piles, monitors having flow rates in excess of 6,000 gpm/monitor would have to be located on opposite sides of the flight deck at 150 ft. intervals, and would have to be erected to a height of 30 ft. to clear parked aircraft.
- h. Monitors mounted at 30 ft. heights in crosswind attacks on the side of a debris pile could not extinguish running fuel fires located closer than 50 ft. from the base of the pile due to shielding of the fire by the simulated aircraft wing (debris pile roof).
- i. High flow monitors present a significant safety hazard to people and aircraft due to the high kinetic energy of the stream.

6. P-16 Improvements

- a. Both PKP and Halon 1211, when used in combination with AFFF solutions, extinguished the debris pile fire. The twin agent unit handline was difficult to use at distances over 20 ft. from the reel, an additional firefighter being needed to help pull hose.
- b. At nominal agent flow rates of 5 lbs./sec. in 30 kt. winds, neither single streams of PKP nor Halon 1211 alone extinguished the debris pile fire, even with the front wall removed. Two streams of Halon 1211, each flowing at 5 lbs./sec. were capable of extinguishing a standard debris pile fire, but would not have prevented ordnance cook-off for the preburn times used in these tests.
- c. Neither PKP nor Halon 1211 were effective in cooling ordnance.
- d. Increasing the turret flow rate from 100 gpm to 175 gpm provided an improvement in fire suppression capability, but in a crosswind, even with the higher flow rate, the P-16 could not extinguish the debris pile fire even when moved up as close as possible to the fire (10 ft.).

7. Robot Tests

- a. A robot can successfully maneuver and attack a fire while pulling a fully charged 3 in. hose and discharging 500 gpm through its monitor.
- b. Robots hold sufficient promise to justify further development and testing.
- c. Stability is a problem for narrow width robots.
- d. The robot used in these tests had a speed of 3-4 mph. A robot would require a significant increase in speed to be a viable unit for flight deck firefighting.

8. Hose Control Devices

- a. Hose control devices can be successfully placed on the deck, tied down and left unattended, thereby permitting firefighters to withdraw from the immediate area while the nozzle continues to flow. These devices were shown to be effective for both fighting fires and cooling ordnance.

9. Weapons Cook-Off

- a. When exposed to a JP-5 pool fire, the propellant inside the weapon will begin to increase in temperature within 15 sec. after exposure, and will usually experience a rate of heat rise of approximately 15-20°F/sec. under wind conditions.
- b. Weapons in a debris pile fire will heat at lower rates, generally 8-10°F/sec., in zero wind conditions.
- c. When weapons in a pool fire are cooled by aggressive attack, using either water or AFFF solution with a 2 1/2 in. handline, the propellant will cool at a rate of 30-40°F/sec. Water alone, however, will not extinguish the fire whereas AFFF solution will.
- d. From earlier experiments at the Naval Weapons Center, it was concluded that cook-off will generally occur when the missile motor case's interior temperature reaches 650°F.
- e. Cook-off temperatures would occur in as little as 45 sec. for Sidewinder missiles in a debris pile fire and 67 sec. for Shrike missiles in a pool fire. The shorter cook-off time for the Sidewinder is due to its lighter motor case construction as compared with the Shrike missile.
- f. Air cooling of weapons previously exposed to fire was virtually the same in wind velocities of 0 to 30 kts. Air cooling alone will provide a temperature reduction of 3-4°F/sec.
- g. A 2 1/2 in. handline provides cooling of 25-35°F/sec. when applied from a 50 ft. stand-off position.
- h. Weapons on the deck will cease to heat and begin to cool at 5-10°F/sec. when the washdown system is used. Weapons suspended 5 ft. or more above the deck will be out of range for the washdown system and hence will receive only air cooling.
- i. Situations were occasionally observed where the agent did not actually extinguish the fire, but gave sufficient cooling so that ordnance heat rise was controlled, thus preventing cook-off.

- j. "Stand-off" stream application showed a slower rate of cooling of a weapon in the debris pile than did aggressive handline attack with either 1 1/2 in. or 2 1/2 in. hose (maximum of 15°F/sec. versus 60°F/sec.). Further, when cooling of the weapon did occur with "stand-off" streams, it began significantly later than was achieved with aggressive handline attack.
- k. Even the best available firefighting system will not guarantee prevention of cook-off, due to the missile motor's sensitivity to heat. Extending the cook-off time of weapons is the most cost effective approach.

10. Stream Reach

- a. Stream reach and accuracy are severely limited by crosswinds.
- b. Increase in crosswind reach is not directly proportional to increase in flow.
- c. Increase in crosswind reach is not directly proportional to increase in pressure.
- d. Directing the stream slightly into the wind increases reach by as much as 30% over a 90° crosswind.
- e. Effective reach in a 90° crosswind at 30 kts. is approximately 1/3 of that under no wind conditions.

11. JP-4 Fires

- a. Even under aggressive attack, a debris pile fire fueled by JP-4 instead of JP-5 could not be extinguished, even by two hose lines using AFFF solution.
- b. The rate of temperature increase in the ordnance was approximately the same for JP-4 and JP-5 fires.

6. ACTIONS TAKEN

As a result of these tests several actions have been taken to date:

- 1. Firefighting doctrine for flight decks has been changed and promulgated to the Fleet.
- 2. The effectiveness of the existing firefighting systems, when installed and used properly, has been confirmed. This information has been promulgated to the Fleet.

3. A program has been undertaken to identify areas on aircraft carriers where additional firefighting capacity may be required and to determine the capability of specific ship systems as installed, to effectively combat fires.
4. A training film for flight deck firefighting has been prepared and issued.
5. The existing program for improving cook-off characteristics of weapons has been accelerated as part of the insensitive munitions program approved by CNO.
6. A program for further development of firefighting robots has been implemented.
7. A program on fire protection for aircraft carrier bomb farms was instituted as a follow-on to these tests.
8. A reexamination of the hazards of JP-4 on flight decks is underway.
9. A major new training initiative has been undertaken--Live Fire Team Training.
10. A hose control device which can provide a greater margin of safety for firefighters is being provided to CV, LHA and LPD type ships.
11. Cost-benefit studies, particularly regarding application of AFFF extinguishing agent by increased flow washdown systems and large volume monitors, have been conducted.
12. High flow rate monitors have been eliminated from further consideration due to limited effectiveness, high cost and ship impact, and safety reasons.
13. Major new emphasis on implementing fire protection improvements into the Fleet has been undertaken under the direction of RADM James A. Webber, Deputy Commander, NAVSEA and Chairman of the CV Firefighting Flag Level Steering Committee.
14. Improvements to P-16 Flight Deck Firefighting Vehicle have been initiated by Naval Air Systems Command.

END

DTic

5-86